PEAT IN THE UNITED STATES

BY EUGENE T. SHERIDAN AND JOSEPH A. DECARLO

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by

Eugene T. Sheridan[1] and Joseph A. DeCarlo[2]

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[1] Commodity-industry analyst, Bureau of Mines, Washington, D. C.

[2] Chief, Coke Section, Branch of Bituminous-Coal Economics and Statistics, Bureau of Mines, Washington, D. C.

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SUMMARY

The United States has extensive reserves of peat. Peat and muck lands are estimated at approximately 79 million acres, with reserves of 13.8 billion net tons. Within the past decade domestic production of peat has increased 2-1/2 times, and apparent consumption has tripled. During the same period imports have increased greatly, and in 1955 they almost equaled domestic production.

The substantial increase in the demand for peat in the United States was due chiefly to expanding markets in agriculture and horticulture, for the reason that in this country peat is used primarily as a source of organic matter to improve the physical condition of mineral soils and as a mulch for shrubbery. A valuable constituent of any soil is its organic matter, and its depletion will injure cultivated soils and subject them to greater erosion.

Animal manures have long been used to improve soils of low productivity, but they decompose rapidly, and supplies in many areas are far from adequate. Crop residues and legumes also are used extensively as sources of organic matter, but they, too, decay rapidly and leave the soil without any marked improvement after a few years. Peat, however, is a source of organic material that will improve and maintain mineral soils, although it, too, will decompose eventually.

Peat has a relatively high nitrogen content, but it is not available rapidly as nutrient material for plants. The benefits derived from the use of peat result largely from the improved physical condition of the soil medium and greater microbiological activity. Another factor in the use of peat as a soil conditioner is its ability to absorb and retain water; however, the water-holding capacities of peats vary, depending upon their botanical character and stage of decomposition.

INTRODUCTION

Peat is one of our most abundant natural resources, but peat deposits in the United States have remained relatively undeveloped for the reason that peat is used chiefly for soil-improvement purposes in the United States; and, until the past few decades, there has been little demand for such a product. Peat is composed, principally, of carbon, hydrogen, oxygen, and nitrogen in varying proportions; and, because it will ignite and burn freely when dry, it is used primarily as a source of energy in many parts of the world. Because the United States has ample supplies of superior fuels, peat is not used as a fuel in this country but is utilized chiefly in agriculture and horticulture. Its use in these fields has increased steadily during the past quarter century, and since 1950 consumption has more than doubled. This trend should continue well into the future.

The rising demand for peat in various parts of the United States has stimulated new interest in our tremendous reserves, and the Bureau of Mines has received numerous inquiries on peat and the peat industry. It is to answer these inquiries and to provide the public with the latest economic and statistical data and other pertinent information on the commodity, that this report has been prepared. The sections of the report devoted to occurrences, properties, and reserves are based on literature published on the subjects. Information on the production, consumption, and uses of peat is based on data voluntarily submitted by the commercial peat producers in the United States.

Peats differ widely in certain chemical and physical properties; therefore, it is important, when using peat for soil-improvement purposes, that the type used is suited to the plant. Some operators produce a blended peat by combining different types. Of particular importance is the pH or degree of acidity or alkalinity, as peats range from strongly acid to mildly alkaline in reaction; as stated, the type used should meet the particular requirements of the plant.

Most imported peats are of the sphagnum-moss type from western Europe and Canada. They are strictly acid in reaction and are only slightly decomposed.

Most peat produced in the United States today is the filled-basin type, which has been formed predominantly from plants of the reed-sedge groups.

The 1954 Census of Mineral Industries, taken by the Bureau of the Census, United States Department of Commerce, provides the latest information on employment, wages, value of buildings, machinery, and equipment, and other economic data relating to the size of the domestic peat industry. This census revealed that production has increased fourfold and employment has nearly doubled since 1939 and, that during the same period, the total horsepower of equipment has increased sevenfold. The average number of men employed by the industry in 1954 was 338, and wages and salaries amounted to $912,000. The combined horsepower rating of equipment in 1954 was 23,000; and total capital expenditures for the industry, including development work, construction, machinery, and equipment, amounted to $194,000.

ACKNOWLEDGMENTS

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Assistance from members of the peat industry also is acknowledged gratefully.

ORIGIN AND CLASSES

Peat is partly decomposed and more-or-less disintegrated vegetable matter that has accumulated in places where ordinary decay or chemical decomposition of the material has been retarded by immersion in water. The plant material consists chiefly of cellulose, hemicellulose, and lignin complexes, which are groups of complex organic materials composed chiefly of carbon, hydrogen, and oxygen, in association with some nitrogenous compounds. When the plant material falls on dry soil, it is attacked by fungi and bacteria and decomposes rapidly. However, when the material falls into water or on soil saturated with moisture, atmospheric oxygen is largely excluded; and, because bacterial activity is controlled by the supply of air, decomposition is retarded and a large proportion of the fixed carbon is retained. Plant debris accumulated under the above conditions results in the formation of peat.

If the organic material remains submerged, decomposition is arrested largely by the formation and accumulation of peat. Peat deposits in the United States usually are formed in areas where water, for the greater part of the year, either saturates or wholly covers the material from which the peat originates. In those places where the material is saturated with water only part of the time and is subjected to periodic and prolonged drying, true peat is not formed, but more complete decomposition takes place. When peat is buried beneath deposits of mud, sand, limestone, or other sedimentary beds and subjected to pressure and heat, the processes of carbonization are continued, and lignite, bituminous coal, anthracite, and graphite result.

The physical properties of peat vary greatly according to origin and the conditions under which it accumulates. Its color may range from light brown or gray to black and its texture from light and spongy to structureless - plastic when wet, but a dense, hard mass when dry.

A survey of literature on peats reveals no general agreement on their classification. Some authors have classified peat deposits according to topography, such as the filled-basin type, the built-up deposit, and the climbing bog, and a composite-area type consisting of built-up peat underlain with peat of the filled-basin type. Others have classified peat according to its physical characteristics, using turfy, fibrous, earthy, and pitchy to describe the textures of different peats, which, of course, depend upon the nature of the vegetation from which the peats were formed. A more acceptable classification is that in which peats are grouped according to their gross botanical composition, as follows:[3]

Sphagnum Group. - Known as the true peat-moss group; formed mainly of several species of sphagnum, usually intermixed with small amounts of various herbaceous plants and shrubs (ferns and heaths). Sphagnum is the large, grayish-green, white and pink moss so widely distributed in the northern parts of the United States and in Canada. Peats of this group normally have a strongly acid reaction. Sphagnum peat is usually loose, spongy, and layered.

Hypnum and Other Mosses Group. - Peats of this group are the remains of hypnum plants, often associated with other mosses and roots of sedges and other flowering plants. They are formed chiefly in areas with slightly acid, neutral, or slightly alkaline reaction. This type is light, spongy, often laminated, and porous.

Reed and Sedge Group. - Peats of this type are formed mainly in shallow areas around the borders of water-filled depressions or in boggy meadows. They consist chiefly of various plants of the sedge family, reeds, grasses, and other swamp plants. Peats of this group are rather fibrous and somwehat matted, but their texture depends upon their degree of decomposition.

Shrub and Tree Group. - Peats of this group are composed mainly of roots, trunks, branches, bark, and twigs of trees, such as the red maple, elm, larch, black spruce, and arborvitae. The material is a tangled mass, not highly decomposed, mixed with the remains of leaves, ferns, shrubs, and rootlets, sometimes in a matrix of more finely divided material.

For the purposes of collecting and compiling economic and statistical data on the peat industry, the Bureau of Mines has classified peat into three general types - moss peat, reed-sedge peat, and peat humus. Peats that do not fall into these categories are listed as "other" types.

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[3] Anderson, M. S., Blake, S. F., and Mehring, A. L., Peat and Muck in Agriculture: U. S. Dept. of Agriculture Circ. 888, 1951, pp. 4-6.

Moss Peat. - Chiefly, the poorly or moderately decomposed stems and leaves of several species of sphagnum, hypnum, or other mosses - light in weight, porous, spongy, and sometimes fibrous but rather free from the woody material of shrubs and trees and other impurities. Sphagnum-moss peat is normally of strongly acid reaction and is confined chiefly to the cool, humid regions of northern New England, the Great Lakes, and the northern Pacific coast. It is the type sometimes referred to as "Highmoor" peat. Hypnum-moss peat usually is slightly acid or neutral in reaction.

Reed-Sedge Peat. - Chiefly, the poorly or moderately decomposed remains of reeds, canes, reedlike grasses, and sedges, such as wire grass, saw grass, rushes, and cattail. Peats of this type are fibrous and matted and sometimes contain the remains of trees and other woody plants; they are formed mainly on the borders of lakes and ponds and also in swamps and salt marshes. Reed-sedge peat is usually slightly acid, neutral, or slightly alkaline in reaction. Sometimes it is referred to as "Lowmoor" peat.

Peat Humus. - Peat so decomposed that its bilogical identity is lost. Humus is formed when peat deposits have undergone cultivation or have been subjected to periods of prolonged dryness. It is dark brown to black, fine-grained, and usually slightly acid or neutral in reaction.

Sedimentary peats and muck are those that generally are designated as "other" types. Sedimentary peat is a layer of finely textured peat that is formed in a water-filled depression by sedimentation of aquatic vegetation. It consists of microscopic and submerged plants, pond weeds, algae, and similar forms of plant life and is the first stage in the development of a peat deposit in a shallow lake or pond. Muck is the finely divided plant debris on any surface portion of peat land that has been cleared and cultivated for farming. It is difficult to draw the line between peat and muck, as peat may grade into muck and muck into peat. The term muck is applied correctly to disintegrated organic matter that contains more than 40 percent mineral matter; however, many areas of the United States that are under cultivation and are referred to as muck lands are cultivated peat lands.4/

Inasmuch as a peat deposit is an accumulation of many generations of plants from one or several groups of vegetation, an individual peat-land area may contain several different types of peat. Peat bogs in many parts of the United States may contain sphagnum, but this does not mean that sphagnum is necessarily the dominant vegetation in the peat bogs. They may consist of another type of peat with a small surface layer of sphagnum. Examination of a peat profile may reveal layers of several different types. Peat that accumulates in ponds or other water-filled basins is built up first by aquatic plants that form a deposit from the bottom and around the sides of the depression. Land plants (sedges, reeds, bulrushes, and grasses), which frequently grow in dense masses in shallow water along the shore, gradually add part of their tissues to the bottom from which they have grown. The more highly organized plants, when sinking, carry with them numerous smaller plants and thus increase the total deposit. The process gradually moves the shoreline into the basin, and periods of drought and low water hasten the advance. In this manner a lake or pond gradually turns into a marsh; and, under such conditions, reed-sedge peat can form.

4/ Dachnowski-Stokes, A. P., Preparation of Peat Composts: U. S. Dept. of Agriculture, Dept. Circ. 252, 1922, p. 2.

As the basin fills, the level of the bog is gradually raised to that of the surrounding country; eventually a turf is formed, which is invaded and held by plants suited to the environment - generally grasses, mosses, and shrubs, later followed by trees. If the water level does not rise, decomposition will pace with the accumulated remains, and peat formation is arrested largely at this point. If, however, the environment changes and the water level rises with the upgrowth of these plants, a new period of peat accumulation begins. Severe changes in environmental conditions also will change the type of vegetation and thus the type of peat; hence, peat deposits may be heterogeneous in structure (fig. 1).

Some peat deposits, formed by the accumulation of plant matter on level or gently sloping surfaces, are called built-up bogs. Mosses, grasses, and shrubs usually contribute dead vegetation; and, although the water level may never rise above the vegetation, it is elevated progressively as the peat collects. Surface conditions remain substantially the same from year to year, and built-up bogs are relatively homogeneous in structure. In certain areas where the air is humid (at sea level or near the ocean) mosses may be the most important form of plant life in the area and may form peat beds of considerable depth and extent. Some of these areas, particularly in eastern Maine, contain deposits built up to more than 20 feet, chiefly by sphagnum mosses.

Because the formation of peat depends upon many factors, the rate of its formation will vary widely. If the climate, topography, and vegetation are favorable, peat will form; but if one or more is unfavorable, the rate of accumulation is retarded. One author believes that the only reliable means of making a rough estimate of the rate at which peat is formed is to estimate the average thickness of some of the largest deposits in the Great Lakes States and the time that has elapsed since the Wisconsin stage of glaciation. Assuming that peat began to accumulate in lakes and ponds soon after final recession of the ice sheet, that 10 to 30 thousand years have elapsed, that the formation of peat was uninterrupted, and that the average deposit contains about 18 feet, then the rate of formation can be computed at approximately 1-1/2 to 4-1/2 feet in 2,500 years.5/ However, these figures are only speculative, as changing environmental conditions affect formation, and it is evident that the rate of formation of most peat deposits has not been uniform.

CHEMICAL AND PHYSICAL PROPERTIES

One of the properties that makes peat valuable to soils is its ability to retain water; however, the water-holding capacities of peats will vary, depending upon their botanical character, the degree of decomposition, and the degree of drying to which they have been subjected. Moss peat has tremendous water-holding power, with properties similar to a sponge; a good grade of moss peat will hold water 15 to 30 times its own weight. This power is diminished, however, when peat is air-dried, and it is not moistened as readily afterward; but air-dried peat still is capable of absorbing and holding much more water than normally is held in most soils. Adding peat to mineral soils alters structural characteristics and increases air space, particularly in clay soils. A high pore space is favorable to the growth of plant roots, aeration, and the movement of moisture, gases, and dissolved salts.

Peat in bulk normally is measured by volume and frequently is sold by the cubic yard. A cubic yard of raw peat generally weighs 800 to 1,400 pounds. Packaged domestic peat usually is shredded and dried further; it generally weighs about 500

5/ Soper, E. K., and Osbon, C. C., The Occurrence and Uses of Peat in the United States: Geol. Survey Bull. 728, 1922, p. 13.

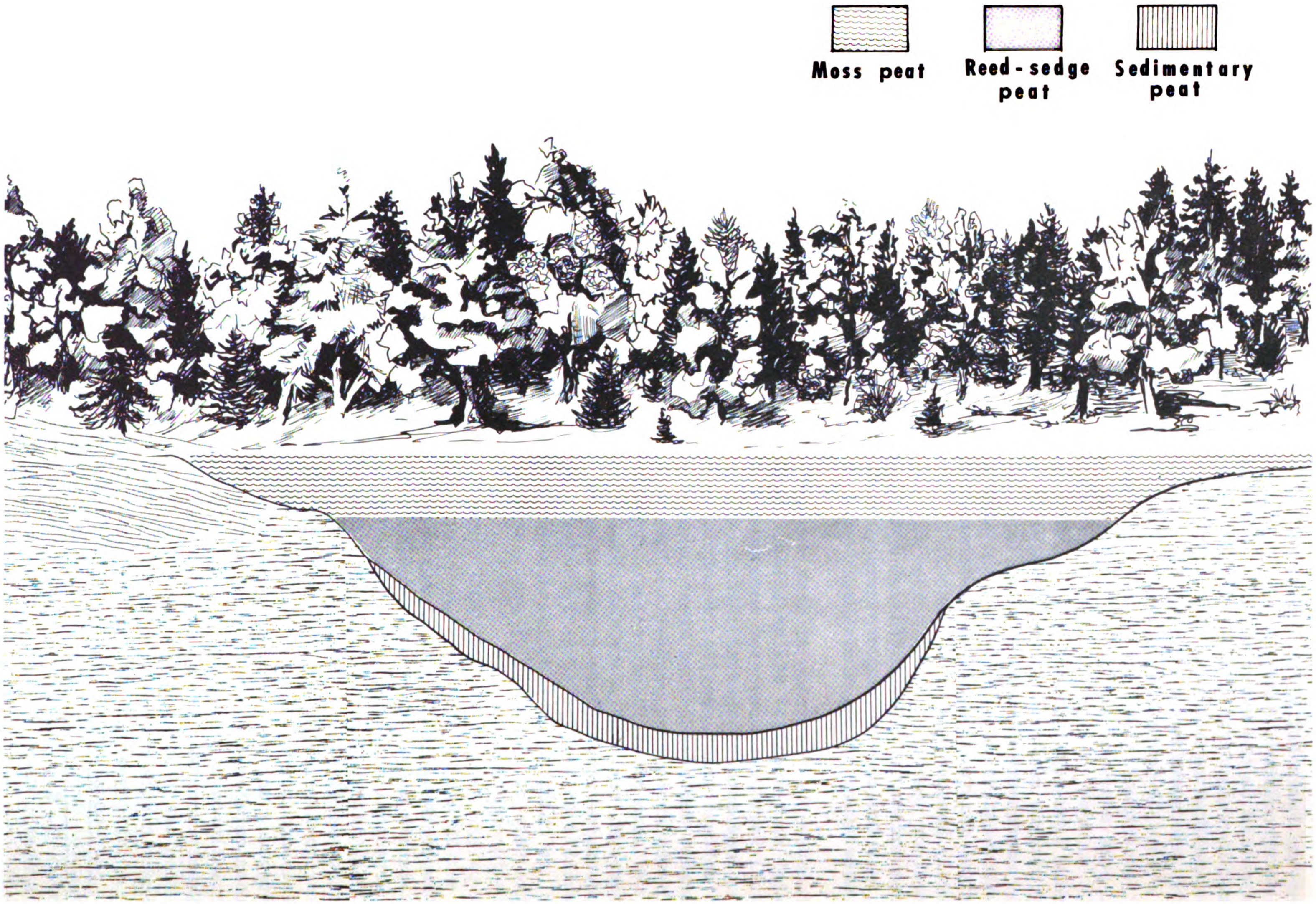

Figure 1. - Profile of a peat deposit (formed in a depression that contained an older body of standing water).

pounds per cubic yard. The texture of peat depends upon two factors - the type of plant material involved in the formation and the degree of decomposition. Textures vary from porous fibers in poorly decomposed sphagnum-moss peats to fine-grained fibers in peat humus.[6]

A property of peat that is important for soil-improvement purposes is its degree of acidity, commonly known as pH. A neutral peat, neither acid nor alkaline, has a pH of 7. Peats with a pH of less than 7 have an acid reaction, and peats with a pH greater than 7 are alkaline. The pH values range from about 3.5 in certain moss peats to about 8 in peats that have been in contact with appreciable quantities of lime or certain fixed mineral salts. It is important that the pH of peat is suited to the requirements of the plant when peat is used for soil-improvement purposes. This is not necessarily a limiting factor, however, for acidity can be corrected by aeration and the use of lime.

The chemical properties of peats also vary, as they differ widely in botanical character and degree of decomposition. The content of lime is variable, depending upon climatic conditions and source of the deposit, but the mineral nutritive ingredients, such as phosphorus and potassium, usually are present in very small amounts. The nitrogen content is relatively high, but it is generally found only in forms slowly available to plants. Hence, peats often are deficient in the necessary nutrient constituents and of little value as fertilizing material. Nutrient deficiencies can be remedied by applying mineral commercial fertilizers and various minor-element requirements as needed.

The organic-matter content, as well as the organic constituents, varies widely in different peats. For soil-improvement purposes a good peat should contain 85 percent or more of organic matter on a dry basis. Generally, sphagnum-moss peat contains the highest percentage of organic matter and the lowest percentage of ash. Analyses have shown that some of the sphagnum-moss peats contain 95 to 99 percent of organic matter, while some of the sedimentary peats contain only 50 to 60 percent. The major constituents of the organic matter are organic complexes of carbon and nitrogen. These consist of greatly varying amounts of cellulose, hemicellulose, ligninlike complexes, complex water-soluble substances, and other unknown compounds that resist decomposition and are referred to as ether-soluble or alcohol-soluble materials.

The approximate chemical compositions of various types of peat and muck are given in table 1.

RESERVES

Peat is found in 30 States in the United States, the principal deposits occurring in Minnesota, Wisconsin, Florida, Michigan, New York, Virginia, and North Carolina. The 16 States in the northern region of the United States - the New England States, the States bordering the Great lakes, and Iowa - contain 80 percent of the total deposits of the country. The 7 States in the Atlantic Coast region, including Florida, contain 19 percent of the total reserves. The Pacific and Gulf Coast States have less than 1 percent. Table 2 gives the approximate distribution of known peat reserves by regions and by States, estimated as air-dried peat. Of the total known reserves (estimated at 13.8 billion short tons in 1922), slightly more than 3 million tons has been consumed.[7]

6/ Dachnowski-Stokes, A. P., Moss Peat, Its Uses and Distribution in the United States: U. S. Dept. of Agriculture Circ. 167, 1931, p. 3.

7/ Soper, E. K., and Osbon, C. C., The Occurrence and Uses of Peat in the United States: Geol. Survey Bull. 728, 1922, p. 92.

TABLE 1. - Chemical composition of peats and muck (dry basis)[1]

Type	Organic matter, percent	Nitrogen (N), percent	Phosphoric peat oxide (P_2O_5), percent	Potash (K_2O), percent	Lime (CaO), percent	Acidity, pH
Sphagnum moss	95-99	0.7-1.2	0.02-0.10	0.02-0.05	0.03-0.80	3.2-4.5
Reed sedge	85-95	1.5-3.0	.05- .20	.03- .09	.70-5.50	4.5-7.0
Woody	75-90	.8-3.5	.06- .25	.05- .15	.30-1.00	3.6-5.5
Sedimentary	60-80	.7-4.0	.03- .20	.01- .30	.5-14.00	4.5-8.0
Muck	40 +	.7-2.5	-	-	-	4.0-8.0

1/ Anderson, M. S., Blake, S. F., and Mehring, A. L., Peat and Muck in Agriculture: U. S. Department of Agriculture Circ. 888, 1951, p. 9.

TABLE 2. - Known original reserves of peat in the United States, estimated on an air-dried basis, by regions and States, in million net tons[1]

Region and State	Reserves	Region and State	Reserves
Northern region:		Atlantic Coast region:	
Minnesota	6,835	Virginia and North Carolina	700
Wisconsin	2,500		
Michigan	1,000	Florida	2,000
Iowa	22	Other States[2]	2
Illinois	10		
Indiana	13	Total	2,702
Ohio	50		
Pennsylvania	1	Other regions:	
New York	480	Gulf Coast[3]	2
New Jersey	15	California	72
Maine	100	Oregon and Washington	1
New Hampshire	1		
Vermont	8	Total	75
Massachusetts	12		
Connecticut	2		
Rhode Island	1		
Total	11,050	Total all regions	13,827

1/ Geol. Survey, Coal Resources of the United States (Progress Report): Circ. 293, 1953, p. 38.

2/ Includes Delaware, Maryland, South Caroline, and Georgia.

3/ Excludes Florida.

Sphagnum-moss peat occurs chiefly in the northeastern part of the United States, particularly in eastern Maine and also in the northern parts of Minnesota, Wisconsin, and Michigan. The formation of sphagnum-moss peat is limited to certain climatic conditions; as a rule, it is found only in the northern region of the United States. It usually is restricted to an area bounded on the south by a line reaching from southern Maine through north-central New York to north-central Minnesota and British Columbia. South of this line reed-sedge peats dominate; however, some high-grade sphagnum-moss peat also is found along the northern Pacific coast in Washington and Oregon.

Minnesota has the largest reserves of peat; its peat lands cover approximately 5 million acres or about one-tenth of its total land area. The most extensive peat deposits lie in the northern part of the State, but some peat occurs in nearly every county except in the western Red River district and the southeastern Driftless Area. There are about 1.3 million acres of peat land in Beltrami County alone, while Koochiching and St. Louis Counties each contain at least 1 million acres of peat, mostly exceeding 6 feet in depth. It has been estimated that the Minnesota deposits could yield almost 7 billion short tons of air-dried peat. Most of the peat deposits in Minnesota occur in spruce and tamarack swamps, known locally by the Indian term "muskeg." As in other States in the northern region, most of the deposits are in basins of glacial origin.

Wisconsin has the second largest deposit of peat in the United States, with about 1 million acres of peat lands capable of yielding approximately 2.5 billion short tons of air-dried peat. Peat deposits are found throughout the State, except in the southwestern area. The northern part is characterized by many large spruce-sphagnum and tamarack-sphagnum bogs and swamps, while many grass-sedge meadows and marshes occur in the southern part. As in Minnesota, most of the peat deposits occur in basins of glacial origin.

Michigan is another State in the northern region that has large peat reserves. The deposits in Michigan are largely in muskegs and grass-sedge marshes in basins of glacial origin, similar in most respects to those in Minnesota and Wisconsin. The principal deposits occur in the northern peninsular area and are fairly well distributed, except for the deposits in Ontonagon and Baraga Counties and those in the southern part of Houghton County. There are also many deposits in the southern peninsular area, but they are much smaller in size. It has been estimated that Michigan peat deposits could yield approximately 1 billion short tons of air-dried peat, 80 percent from the northern Peninsula.

The Atlantic Coast region has many workable deposits of peat in southern Delaware, the eastern parts of Maryland, Virginia, North Carolina, South Carolina, and Georgia, and most of Florida. This region is characterized by many salt- and fresh-water marshes and swamps, and the deposits have been formed principally from trees, reeds, sedges, and marsh grasses. There is relatively little sphagnum in the Atlantic Coast region, and both coniferous and deciduous trees contributed much of the vegetable matter from which the peat was formed.

The largest deposits of good peat in the Atlantic Coast region are in Virginia, North Carolina, and Florida. The most extensive deposits in Virginia occur in the Dismal Swamp area, which extends southward from Portsmouth into northern North Carolina. Much peat found in North Carolina is in the Dismal Swamp area. Peat deposits occur in almost all parts of Florida, which probably has more peat than any other State except Minnesota and Wisconsin. Deposits in Florida are estimated to be capable of yielding 2 billion short tons of air-dried peat - half from the Everglades.

Considerable peat is found in California, and small amounts occur in Washington and Oregon. The principal deposits in California are in Siskiyou, Los Angeles, Orange, and San Bernardino Counties and in the valleys of the Sacremento and San Joaquin Rivers. Peat and muck deposits in the Sacremento-San Joaquin Delta area cover an estimated 400 square miles. Some peat also is found in the marshes adjoining San Francisco Bay and the Salinas River. The largest deposits in Washington are in King, Kitsap, and Snohomish Counties, bordering Puget Sound. Most peat in Oregon is in Jackson and Klamath Counties.

Small deposits also are found in a narrow belt adjoining the Gulf coast. Very little peat of any type occurs in the Appalachian and Rocky Mountain regions. This is due primarily to the rapid runoff of surface waters.

PRODUCTION METHODS AND EQUIPMENT

Peat-production methods in the United States are relatively simple, although almost all operations are mechanized to some extent. No one method of producing peat is suitable for all peat lands, and most of the techniques being used today have been devised by individual operators to meet conditions peculiar to their operation.

Excavation is one of the major problems in producing peat. Over the years, especially in Europe, a number of mechanical excavators have been developed; however, these never have been utilized to any extent in the United States. Instead, conventional excavating and earth-moving machinery or modifications generally have been employed. Power shovels, scraper loaders, tractor-drawn scrapers, bulldozers, cranes equipped with draglines and clamshell buckets, and nonmobile draglines are the types of excavating equipment generally used.

Drainage is a problem at most peat operations; generally it is necessary to install drainage systems so that the surface of a bog will support the weight of operating equipment. In some instances, however, where peat deposits fill basins formerly occupied by ponds or lakes, it may be impracticable to provide drainage, and these deposits must be worked by specially adapted equipment.

It is not within the scope of this circular to describe in detail production methods employed at the various operations throughout the country. A few techniques are described however that will illustrate the marked differences in methods and types of equipment employed.

In upper New York State a deposit of reed-sedge peat (filled-basin type) is excavated and prepared for market in the following manner: Wooden pallets (4 by 10 feet) are laid out on the surface of the bog to provide a roadbed for the operating equipment, because the surface is not firm, and it is impracticable to provide drainage. Excavating equipment consists of a crane, equipped with a clamshell bucket, and trucks for hauling peat to the drying area. The crane moves into the bog on the roadbed to the excavating area, and a truck follows and remains behind the crane. After loading its bucket with peat, the crane turns 180° on its axis and deposits the load in the truck; the truck, when full, conveys the peat to the drying area and dumps it on the ground. After the peat has been excavated, the crane withdraws, and water fills the excavated area. In the drying area peat is spread on the ground in beds about 4 feet high, where it remains all winter; frost breaks the plant tissues and produces a more absorbent peat. By the following summer it has been cured enough to use.

If shredding is not required, the peat is loaded into trucks for bulk shipment by a light power shovel equipped with a rear-end loader. This particular shovel can load an 18-cubic-foot truck bed in 15 to 20 minutes and is preferred to heavier equipment because of its mobility.

If shredding is required, the peat is lifted from the drying beds and passed through a mobile shredder, after which it may be sold in bulk or further air-dried indoors and packaged. Most of the production at this operation is shredded peat, which is sold in bulk and weighs about 800 pounds per cubic yard. The packaged peat, which is much drier, weighs about 450 pounds per cubic yard.

In contrast to the above-described method of production a large reed-sedge deposit in northern New Jersey is worked by an entirely different process, known as cultivation. Cultivation requires turning over the surface of a peat deposit at intervals for a period of time, a procedure that aerates peat, gradually decomposing and changing it to humus. Drainage is required for the operation and is provided by lateral trenches, which lower the water table of the bog enough to support the specially adapted caterpillar treads of the operating equipment. Peat is cultivated by tractor-drawn, spring-toothed harrows, then scraped into windrows for drying by large, mobile, bucketline cranes; later, the cranes load the peat into small, narrow-gage railroad cars for delivery to the shredding and packaging equipment. After the peat has been shredded and screened, it is placed in hoppers and either packaged or loaded out in bulk.

These operations are two of the more completely mechanized processes now being used. Many others are not as mechanized and still require considerable hand labor. Two such unmechanized operations are located in the eastern part of Maine, where sphagnum-moss peat is excavated by hand. Here peat is cut into blocks and laid on the surface of the ground by two hand implements resembling shovels; the excavated blocks are then placed upon racks or stacked to dry, after which the peat is shredded, screened, and baled. Like imported peats of the same type, this peat can be baled for shipment, as it retains its water-absorbent properties when dried and is of the proper texture.

Figures 2 and 3 show production equipment used in Florida. Figure 4 shows peat excavated from a bog in New York, drying in windrows after shredding. Figure 5 shows an excavated bog that has filled with water.

PRODUCTION AND CONSUMPTION

Peat has been produced and consumed in the United States almost continuously from the days of the first settlements, but the peat industry cannot be said to have existed in the United States until the early years of the 20th century. Although limited attempts were made previously to produce peat commercially for fuel, it was not until 1903, when striking anthracite miners caused a severe fuel shortage, that much effort was directed toward producing peat on a commercial scale.

Since then, production has gradually increased and 273,669 net tons of peat, valued at $2,282,865, was produced in 1955. Within the past decade, domestic production has increased more than 2-1/2 times, and apparent consumption has almost tripled. However, the demand for peat in the United States has been met only partly by domestic production, and in recent years about half of the quantity consumed was imported. Table 3 gives pertinent statistical data on the industry for selected years from 1920 through 1955.

Eighty-two producers in 18 States reported production of peat in 1955. Table 4, which gives quantities and values of peat production by States since 1953, indicates that Florida and Washington are now the major producing States, with a combined production in 1955 of 36 percent of the total. Michigan, New Jersey, Pennsylvania, and Ohio also produce substantial quantities.

Table 5 gives quantities and values of different types of peat produced. Peat humus is the type produced in the greatest quantities in the United States, and in 1955 humus supplied nearly half of the production. Reed-sedge peat ranks second in production, and moss peat is third. A small quantity of "other" types also is produced each year. Approximately half of the production is processed by shredding or kiln drying or by both processes.

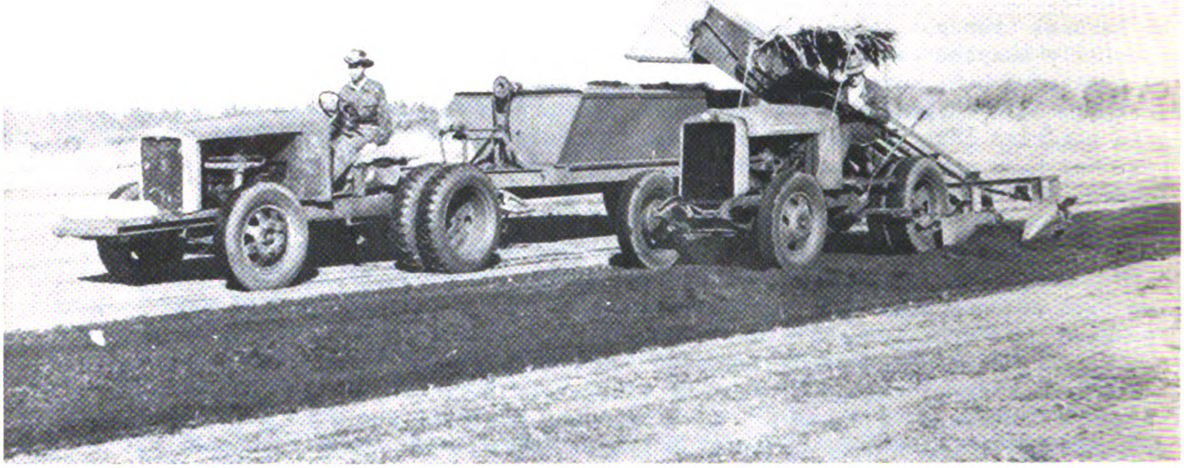

Figure 2. - Mobile elevator lifting peat from windrow to truck.
(Courtesy, Agricultural Res. Service,
United States Department of Agriculture.)

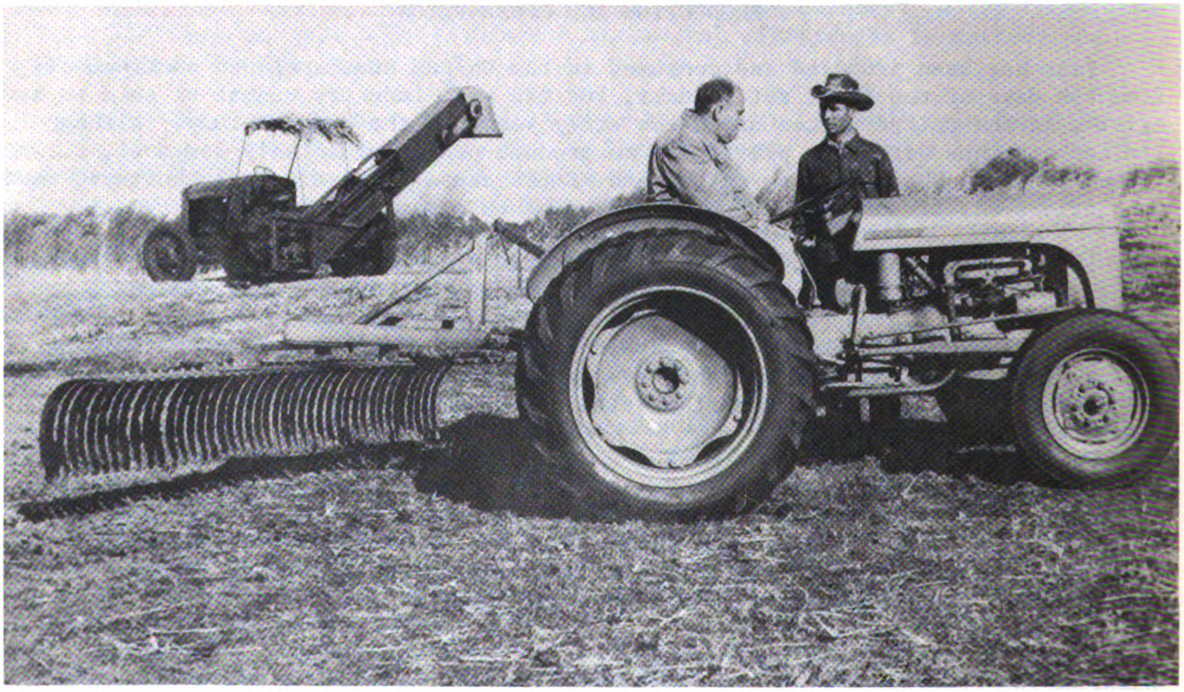

Figure 3. - "York rake" type of recovery equipment.
(Courtesy, Agricultural Res. Service,
United States Department of Agriculture.)

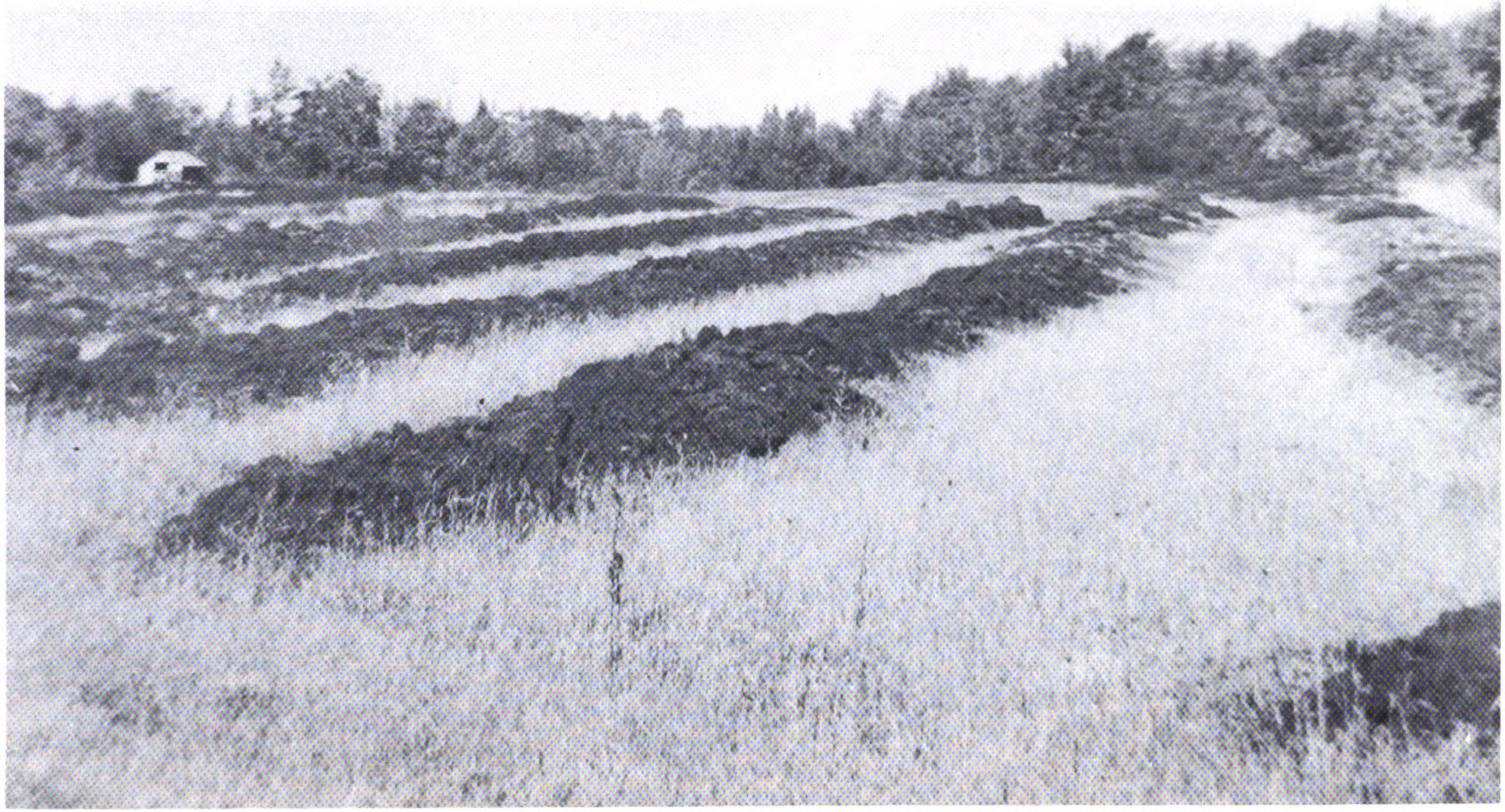

Figure 4. - Peat drying in windrows after shredding.
(Courtesy, Junius Peat Co.)

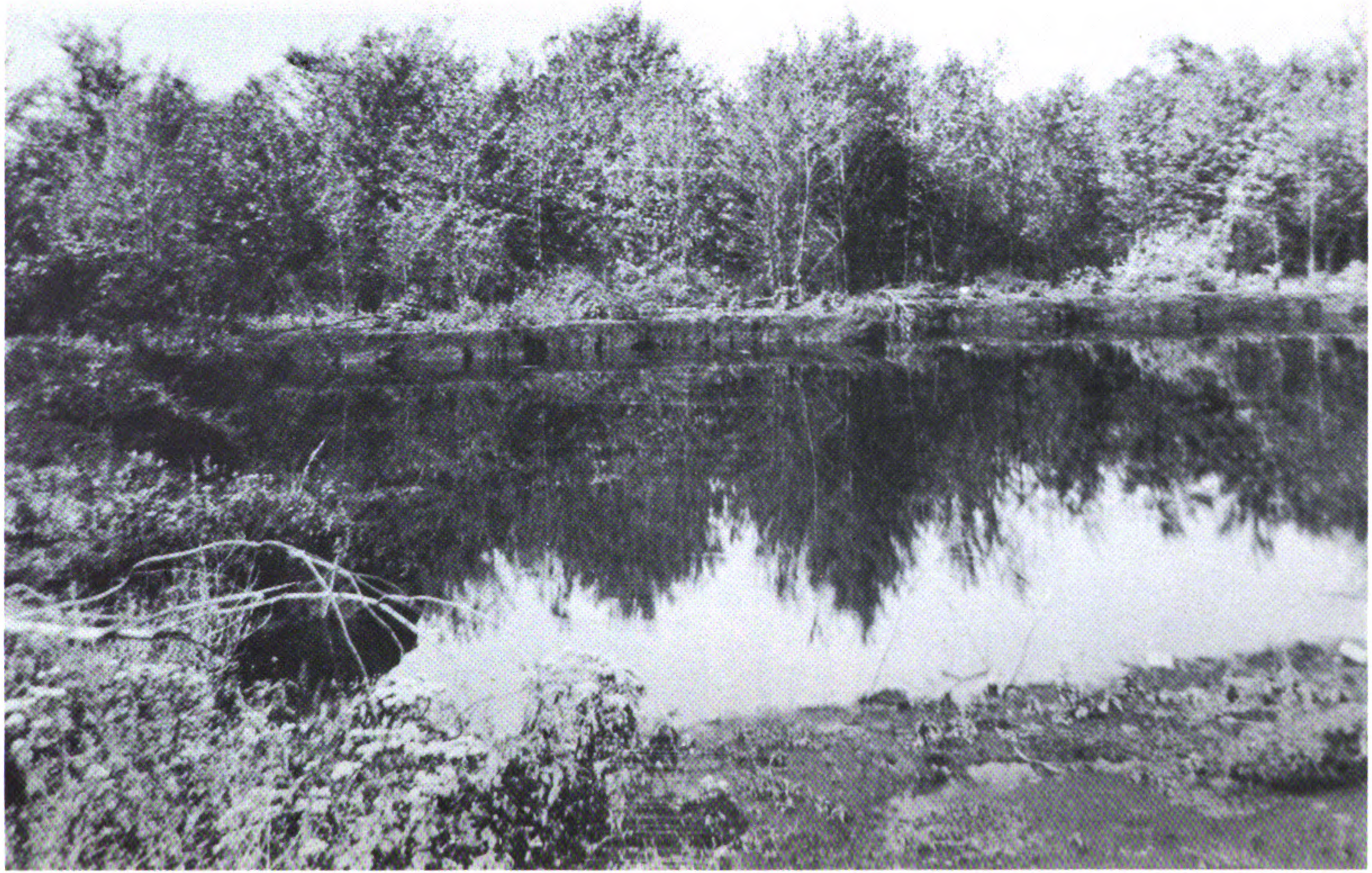

Figure 5. - An excavated bog that has filled with water.
(Courtesy, Junius Peat Co.)

TABLE 3. - Salient statistics of the peat industry in the United States for selected years

	1920	1925	1935	1940	1945	1950
Number of producers	18	(1)	40	50	51	48
Production .... net tons	73,204	72,436	37,060	70,097	2/107,000	130,723
Imports .... do. ..	2,762	10,233	54,547	21,689	77,673	124,382
Apparent consumption .. do. ..	75,966	82,669	91,607	91,786	184,673	255,105
Value:						
Production	$921,732	$452,898	$199,377	$516,865	$821,000	$1,142,566
Imports	36,201	121,719	677,513	454,632	2,393,214	3,866,927
Average value per net ton:						
Production	$12.59	$6.25	$5.38	$7.37	$7.67	$8.74
Imports	13.11	11.89	12.42	20.96	30.81	31.09
Major producing States ....(	Illinois New Jersey	New York New Jersey	New York New Jersey	New York New Jersey	Florida New Jersey	New Jersey Florida

	1951	1952	1953	1954	1955	
Number of producers	63	62	68	85	82	
Production .... net tons	194,416	210,582	204,209	244,163	273,669	
Imports .... do. ..	144,390	167,404	199,887	240,940	229,310	
Apparent consumption .. do. ..	338,806	377,986	404,096	485,103	502,979	
Value:						
Production	$1,489,225	$1,729,511	$1,617,947	$2,257,591	$2,282,865	
Imports	4,850,536	6,502,452	7,333,749	8,836,325	9,261,820	
Average value per net ton:						
Production	$7.66	$8.21	$7.92	$9.25	$8.34	
Imports	33.59	38.84	36.69	36.67	40.39	
Major producing States ....(	Washington New Jersey	Washington Michigan	Washington Ohio	Washington Florida	Florida Washington	

1/ Not available.
2/ Estimated.

TABLE 4. - Peat produced in the United States, 1953-55, by States

State	1953		1954		1955	
	Net tons	Value	Net tons	Value	Net tons	Value
California, Colorado, and Idaho	15,263	$126,985	17,618	$194,453	20,207	$208,784
Florida	27,678	185,524	37,449	168,004	61,098	231,829
Georgia and Texas	3,680	54,560	7,456	83,979	5,554	49,410
Illinois, Indiana, and Iowa	26,303	198,786	33,457	362,149	31,520	252,617
Michigan, Minnesota, and Wisconsin	25,805	259,026	28,797	438,016	29,793	466,637
New England	11,964	119,976	8,918	130,369	10,116	210,474
New Jersey and New York.	25,481	260,826	22,173	229,241	31,980	280,805
Ohio	27,696	260,474	29,540	356,970	22,484	249,427
Pennsylvania	8,232	47,516	15,621	141,352	23,277	219,628
Washington	32,107	104,274	43,134	153,058	37,640	113,254
Total	204,209	1,617,947	244,163	2,257,591	273,669	2,282,865

TABLE 5. - Peat produced in the United States in 1955, by types, in net tons

Kind	Total		Raw	Prepared	Type of preparation		
	Quantity	Value			Cultivated	Shredded	Kiln-dried
Moss	32,449	$424,143	2,772	29,677	6,818	22,859	-
Reed-sedge	83,694	976,236	5,951	77,743	45,645	32,098	-
Humus	127,085	804,921	40,860	86,225	4,051	62,359	19,815
Other[1]	30,441	77,565	26,401	4,040	3,090	950	-
Total	273,669	2,282,865	75,984	197,685	59,604	118,266	19,815

1/ Predominantly muck.

The apparent consumption of peat in the United States may be considered equal to domestic production plus imports, as little, if any, peat is exported, and, normally, none is stocked. Figure 6 illustrates the quantities of peat produced and imported for representative years from 1920 through 1955. Imports always have figured prominently in consumption, and in recent years apparent consumption has been twice the quantity of domestic production.

Uses

Peat has been used as a fuel for centuries, especially in northern Europe and inland, where it has been the prevailing fuel of the poorer classes. In Europe today large quantities still are being used for domestic heating; and several countries, particularly Ireland and the U. S. S. R., consume large quantities to generate electric power.

In the United States, however, no peat is sold commercially for fuel, for it cannot compete with the ample high-grade fuels that are available. Instead, peat is used chiefly for soil-improvement purposes - for constructing and improving lawns and golf-course greens, improving garden soils, and growing plant life in general.

Figure 7 illustrates the use of domestic peat during the past 10 years. The annual consumption of peat for soil improvement has increased steadily since 1949; 85 percent of the total consumption was used in this manner in 1955.

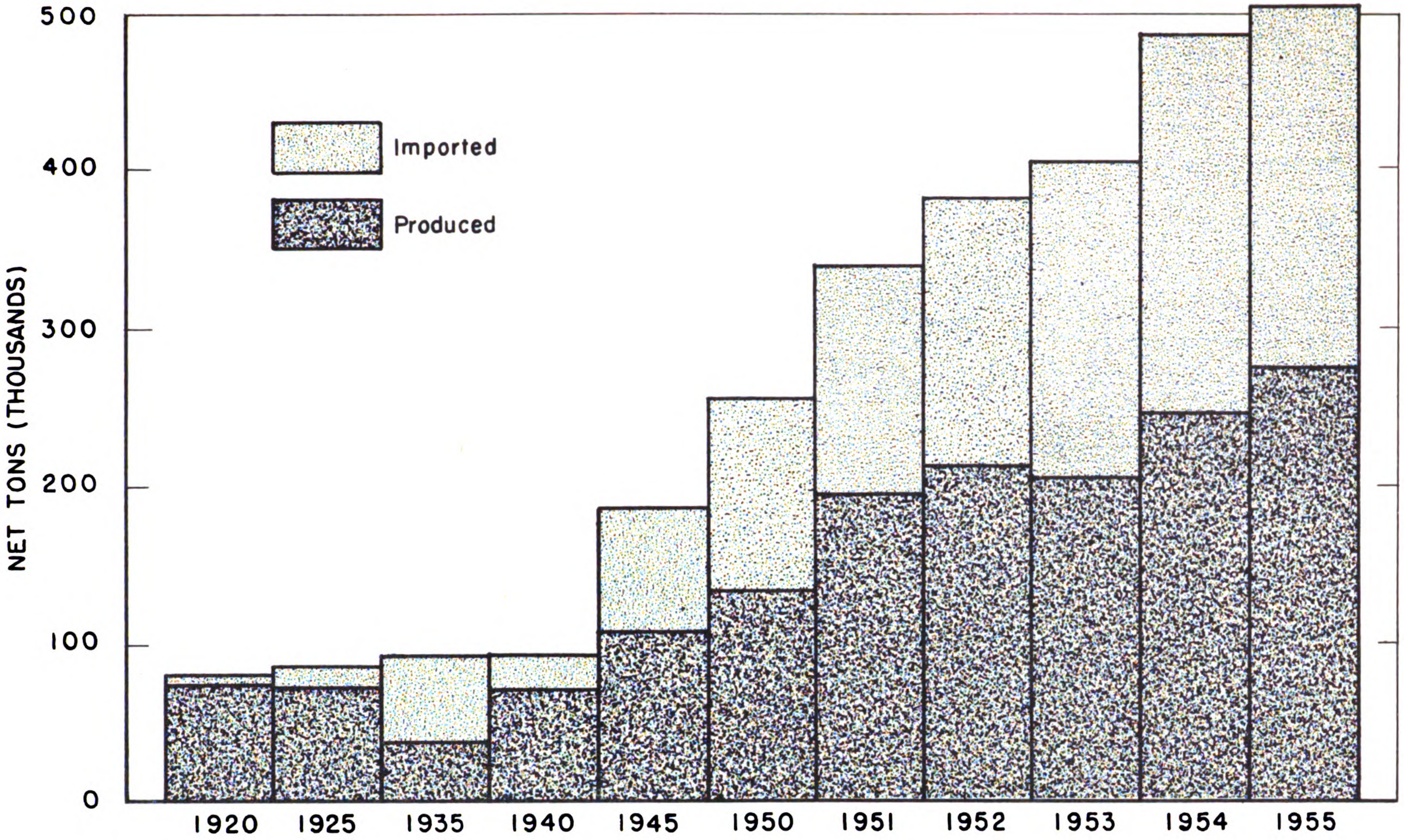

Figure 6. - Sources of peat consumed in United States, 1920-55.

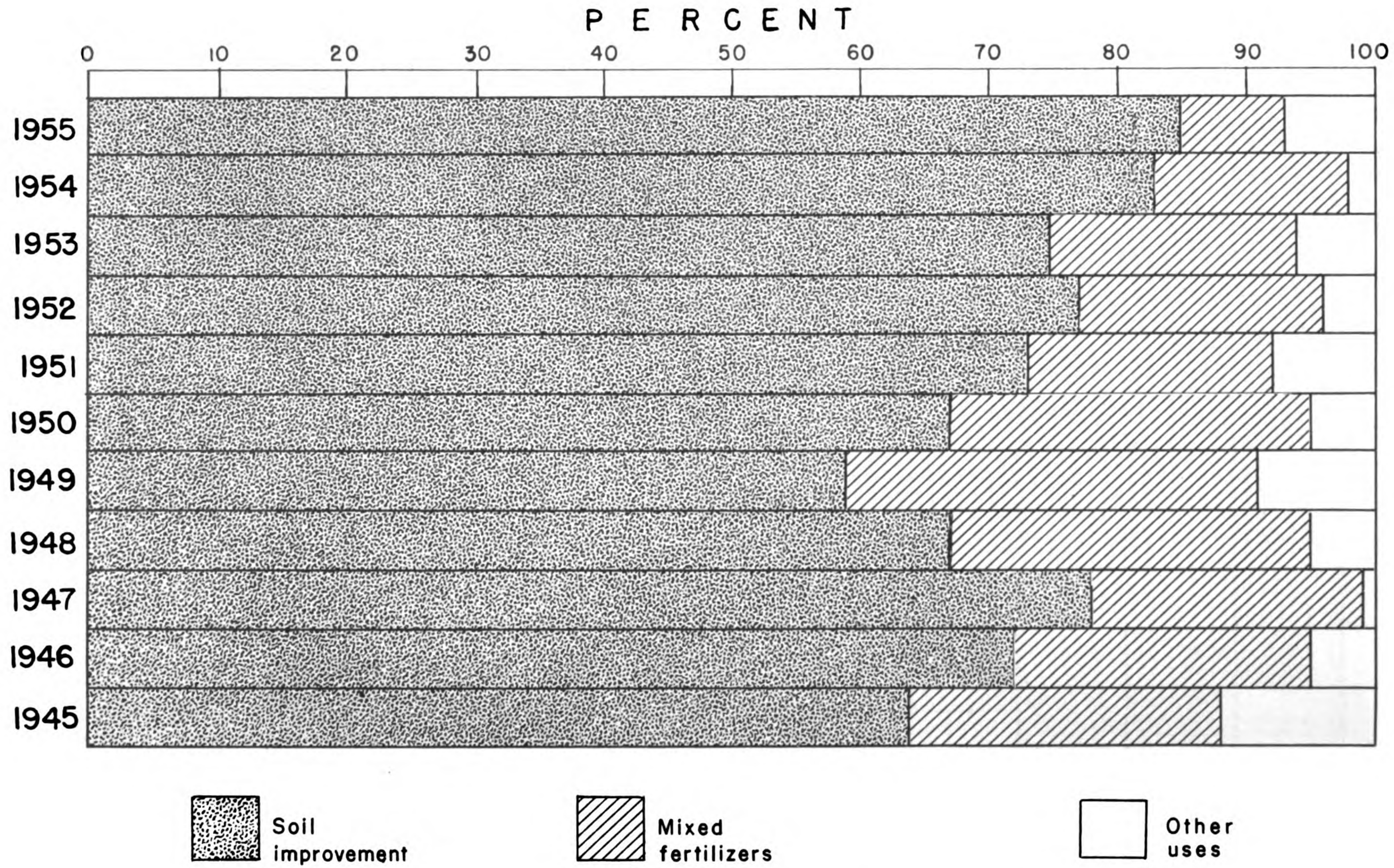

Figure 7. - Use pattern of peat produced and sold in United States, 1945-1955.

Although peat has a relatively high nitrogen content, it is not used as a direct fertilizer because the nitrogen is usually available very slowly to plants; the content of the various other nutrient constituents of peat, such as phosphoric oxide (P_2O_5)and potash (K_2O), is too low[8] to have any significance. Benefits derived from using peat result largely from the improved physical condition of the soil medium. Adding peat to a mineral soil changes the structural characteristics of the soil and improves its texture and water-holding properties.

Approximately half of the peat being consumed in the United States is imported; therefore, it is important to note a few of the differences between imported and domestic peats.

Nearly all imported peat is sphagnum-moss peat, which consists chiefly of a slightly decomposed, highly fibrous material that is strongly acid in reaction. It resists decomposition, and its rate of change in the soil is slow. The acid condition can be altered by adding lime, but decomposition still is slow. Sphagnum-moss peat is widely used for soil-improvement purposes, but it should be used only for plants that require a strongly acid soil. It is used chiefly for mulches and as a medium for germinating seeds and starting cuttings. It is also used by many nurseries for surface-mulching evergreen trees and shrubs. Imported moss peats, with properly adjusted pH values, can be used for building lawns, but domestic reed-sedge peats usually are preferable.

A small quantity of moss peat produced in the United States has properties similar to imported peats, but most domestic moss peat is in a more advanced state of decomposition, with properties similar to the slightly acid reed-sedge peats. The more decomposed domestic moss peats, which generally are used for the same purposes as imported peats, are also used as top dressings for lawns and are sometimes mixed with reed-sedge peats to build lawns. The reed-sedge peats are widely used for building lawns and for general soil-improvement purposes that require a slightly acid, neutral, or slightly alkaline medium.

An important difference between imported and domestic peats, particularly from a production standpoint, is in the packaging requirements. Most imported peat is produced in bales because it has the proper texture for baling and can be air-dried to a low moisture content and retain its water-holding properties. Because domestic peats are more decomposed and less fibrous than the imported peats, most domestic peats are unsuitable for baling; when kiln-dried, they have difficulty maintaining their water-holding properties. Generally they are sold in bulk but sometimes are packaged in a moist condition in polyethylene bags.

The second largest use for peat in the United States is in preparing mixed fertilizers. Because of its moisture-absorbing properties, dry, finely ground peat is sometimes added to a commercial fertilizer to reduce stickiness and caking. When used for this purpose, peat also acts as a filler material to complete the formula. Reed-sedge peat that will pass through a 5- to 10-mesh sieve and contains less than 10 percent of moisture is the type normally used to condition the fertilizer. In recent years, however, the use of peat in mixed fertilizers has decreased somewhat, owing to a process known as pelletizing (granulation), which eliminates the need for a conditioning agent.

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[8] Lipman, C. B., and Wank, M. E., The Availability of Nitrogen in Peat: Soil Sci., vol. 18, July-December 1924, pp. 311-316.

Smaller quantities of peat are used in the United States for miscellaneous other purposes. Sphagnum-moss peat is used as bedding material for horses and cattle and as poultry litter, because it is capable of absorbing more moisture than any other substance generally used for stock bedding and prevents decomposition of waste materials for a considerable period of time. Most peats used for these purposes eventually become fertilizer. Moss peat is also used commonly as a packing material for cut flowers and plants that must have moisture during shipment. Reed-sedge peat is used extensively to protect the roots of rose bushes and other plants while in shipment. A small amount of peat is also used to cure concrete on newly constructed highways.

During World War I considerable quantities of sphagnum-moss peat were used in the United States for surgical dressings and mattresses. Its absorbent, deodorizing, and antiseptic properties made it superior to other materials available at that time, and approximately one-fourth of the total consumption in 1918 was used in this manner. One report states that during World War I the American Red Cross prepared nearly 600,000 peat-moss pads, which were used in military hospitals at home and abroad.[9]

Value and Price

The value of domestic peats has changed over the years but has remained fairly stable during the past decade; in 1955 it averaged $8.34 per ton. The value of imported peat, however, has increased steadily each year since 1935, and in 1955 the average value per ton was nearly 5 times that of domestic peat. The great differences in value are due primarily to the fact that most imported peat is packaged or sold in bales and marketed through normal retail channels, whereas most peat produced in the United States is sold in bulk and, to a great extent, within the area where it was produced. Also, the value of domestic peat is reported at the primary producing level, f.o.b. plant, whereas the value of imported peat is established at the port of embarkation and is equivalent to the price paid by an importer, less the cost of transportation and miscellaneous other charges. Actually, the retail prices of foreign and domestic packaged peats of comparable quality essentially are competitive. Since World War II the average value of imported peat has been greatly influenced by imports from Canada, because a large part of the total imports are supplied by Canada at values substantially higher than for peat from other countries. However, transportation and marketing costs are much lower on Canadian peat, and its final market price compares favorably with that of peat from Europe. Although the average value per ton of packaged domestic peat was $20.84 in 1955, several producers sold packaged peat for more than $50 per ton. Bulk sales which were nearly 90 percent of the total, substantially lowered the value of total sales (table 6). Figure 8 illustrates the trend in prices for domestic and imported peats for 1920-55.

TABLE 6. - Peat sold in the United States in 1955, by uses

Use	Bulk			Packaged			Total		
		Value			Value			Value	
	Net tons	Total	Average	Net tons	Total	Average	Net tons	Total	Average
Soil improvement	198,790	$1,212,184	$6.10	25,719	$594,788	$23.13	224,509	$1,806,972	$8.05
Mixed fertilizers	20,976	218,999	10.44	-	-	-	20,976	218,999	10.44
Other uses..	10,774	67,052	6.22	8,101	110,067	13.59	18,875	177,119	9.38
Total ...	230,540	1,498,235	6.50	33,820	704,855	20.84	264,360	2,203,090	8.33

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[9] Soper, E. K., and Osbon, C. C., The Occurrence and Uses of Peat in the United States: Geol. Survey Bull. 728, 1922, p. 73.

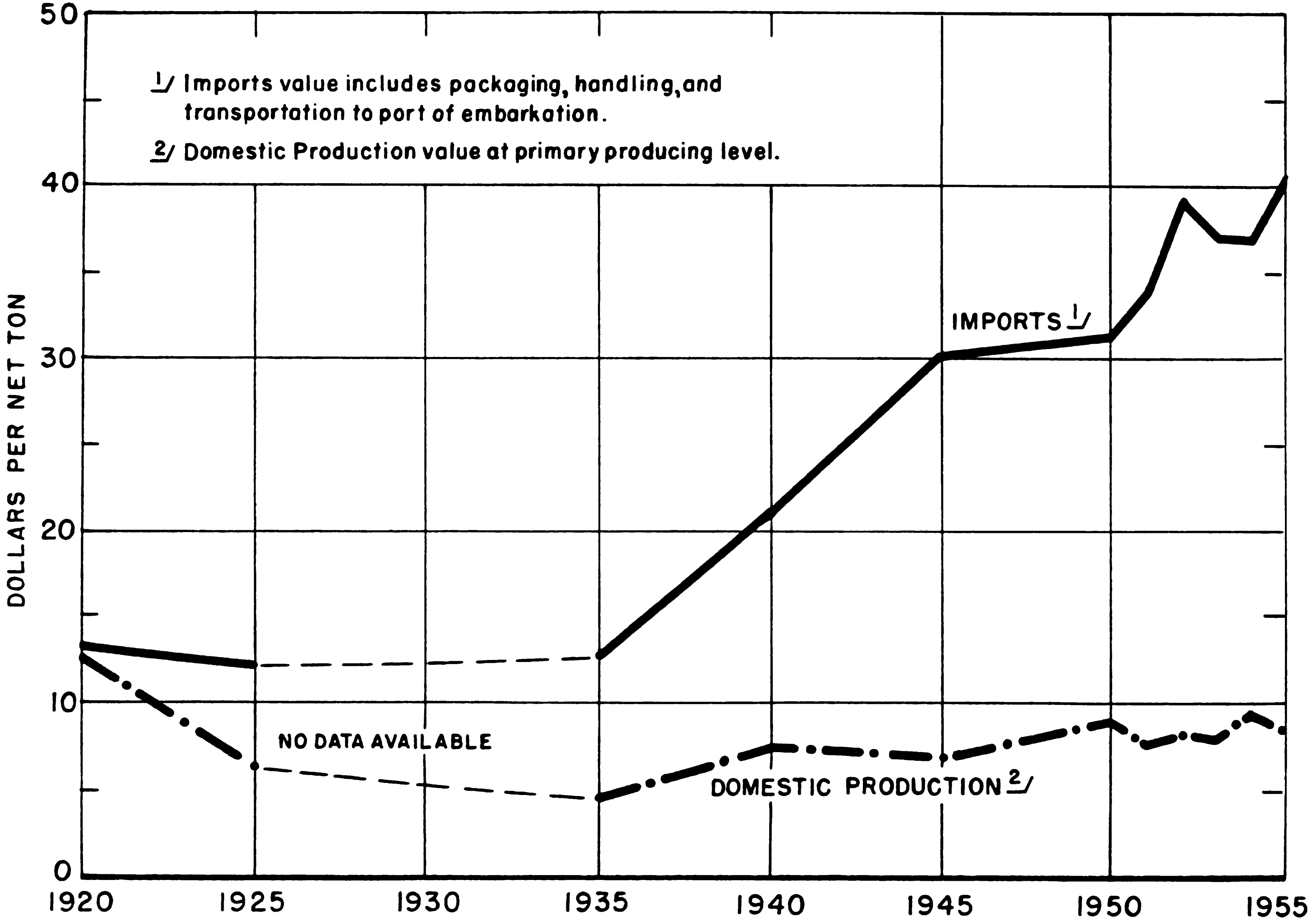

Figure 8. - Average value of domestic and imported peats in United States, 1920-55.

The values of domestic peat vary extensively, even within a State, and it would be incorrect to determine that any one type is more valuable than another. Generally, however, any peat that has been processed further has a higher value. This applies especially to reed-sedge peat that has been shredded and kiln-dried for use in mixed fertilizers.

Marketing

The peat industry in the United States is small and is composed chiefly of independent producers operating on a small scale. Of the 82 who reported production of peat in 1955, 66 produced less than 5,000 tons, and 29 of the 66 less than 1,000 tons.

Several factors have restricted development of the peat industry, but probably the chief factor is the nature of the product. Peat has a high moisture content after it has been processed; and, until recently, no suitable materials were available in which peat could be packaged economically and shipped without deterioration. Kiln-dried peat is unsuitable for soil improvement, as thermal heating destroys its bacterial content and greatly reduces its water-holding capacity. As a result, producers have had to depend chiefly upon local markets, and operations have remained small. With the introduction a few years ago of polyethylene products and other paper and textile bags treated with synthetic resins, it is now feasible to package, store, and ship peat; and in 1955 sales of packaged peat were 13 percent of the total.

Several large producers now have wide distribution of their product, and packaged domestic peat now can be found in stores and other retail outlets where formerly only imported peat was available. Standard sale units are 25-, 50-, and 100-pound bags; and retail prices range from approximately $1.50 for 25 pounds to $5 for 100 pounds.

To eliminate unfair or deceptive trade practices, the peat industry is governed by trade-practice rules established by the Federal Trade Commission in 1950. These rules have provisions designed to inhibit specific misrepresentations and the deceptive use of trade or corporate names. They also prohibit other forms of misrepresentation, as well as practices that tend to lessen competition.

The Bureau of Federal Supply, United States Department of the Treasury, has issued Federal Specifications for use of Federal agencies when purchasing peat. These specifications divide peats into types and classes and list general and detailed requirements for each.

Foreign Trade

Most peat imported into the United States is of the sphagnum-moss type from western Europe and Canada. For the past 10 years, an average of 44 percent of the peat consumed has been imported, the greater part from Canada. Since 1952, however, West Germany has been the leading source of foreign peat, with Canada following closely in second place. In 1955, 51 percent of the imported peat came from West Germany, 45 percent from Canada, and the remaining 3 percent from the Netherlands, Denmark, Ireland, Finland, United Kingdom, and Sweden.

The Canadian peat industry was developed almost entirely since 1940 to supply United States markets that were cut off from European sources during World War II. Almost all peat produced in Canada is exported to the United States.

Imported peat is classified by the United States Department of Commerce into two grades, according to use:

1. Poultry and stable grade.
2. Fertilizer grade.

Fertilizer grade has constituted about 90 percent of the total imports over the past 5 years.

A duty of $0.25 per ton is levied on all imported peat classified as poultry and stable grade; peat for agricultural purposes is duty free.

Little, if any, peat is exported from the United States.

OUTLOOK

The future of peat in the United States as an agricultural product seems assured. More and more, people are becoming aware that soils must be replenished if they are to remain productive year after year. Whereas the farmer replaces organic matter in his lands by plowing under cover crops and plant residues, the landscape gardener, the nurseryman, and the homeowner conveniently acquire the same or better results by using peat. Peat is now accepted generally as an economical and lasting source of organic matter for soil improvement.

Peat resources in the United States also constitute a possible future source of energy and chemical raw materials. Actually, on a global basis, the amount of peat consumed in agriculture is insignificant, for in 1955 98 percent of world production was used for energy purposes. To gain some understanding of the significance of our deposits, we can look at developments in European countries.

Perhaps the most notable example is in the U. S. S. R., with an estimated annual production in 1955 of 56 million tons, a large part of which was consumed to generate electric power. Faced with the problem of industrial expansion in areas remote from supplies of high-grade fuels, the Soviet Union for economic and, probably, strategic reasons, has utilized peat resources (available in vast quantities in these areas) as a source of energy. Powerhouses generating several hundred thousand kilowatts of electric power are now operated with peat; and large amounts are consumed for gasification purposes, with byproduct recovery in some instances.

Ireland is another country that has utilized peat resources for generating electric power and for industrial development. Two peat-fired power stations are being operated, and a third station is scheduled for completion in 1957. The station now under construction will have an estimated output of 412 million units a year and is expected to be the largest peat-fired station in the world outside of the U. S. S. R. Both Germany and Sweden are using peat to a limited extent to generate electric power, and a 2,000-kilowatt closed-cycle, peat-fired gas turbine is being constructed in Scotland.

Peat has been carbonized in some European countries, particularly in Germany and the U. S. S. R., to replace charcoal for domestic heating and smelting iron. Peat coke is high in carbon content, low in sulfur, phosphorus, and ash, and has a calorific value of about 13,000 B. t. u. per pound. It is not suitable, however, for all metallurgical applications. Processes have also been developed to recover waxes and chemicals from peat, but generally the processes are uneconomical.

Continued research undoubtedly will advance technology and make peat a possible future source of raw material for the chemical industry in these countries.

Despite the large-scale utilization of peat for energy in European countries, it is not expected that peat will be used for energy purposes to any great extent in the United States in the near future; estimated recoverable coal reserves in this country are of such magnitude that they will last for many generations, even assuming large increases in consumption. It is unlikely therefore that (low-grade) peat will be utilized as long as (high-grade) coal can be economically recovered, for the reason that the production of peat cannot compare with the production of coal on a cost basis.

It is possible that certain areas that are remote from coalfields and contain extensive peat deposits will develop them to the point where peat will be competitive with other fuels locally. The Iron Range Resources and Rehabilitation Commission of Minnesota has been actively conducting studies to determine methods and processes for industrial utilization of peat in such areas. These studies have been directed mainly toward utilization of Minnesota peat deposits for generating electric power and beneficiating iron ores.

STATISTICAL APPENDIX

Historical statistics of peat industry in the United States, 1908-26 and 1934-55

Year	Number of plants	Production			Imports		
		Net tons	Value	Average value per ton	Net tons	Value	Average value per ton
1908	(1)	24,800	$133,000	$5.36	9,074	$45,414	$5.00
1909	(1)	29,167	127,042	4.36	9,408	47,227	5.02
1910	12	37,024	140,209	3.79	8,953	41,938	4.68
1911	14	55,143	281,504	5.10	9,022	39,372	4.36
1912	12	47,380	228,572	4.82	9,053	39,867	4.40
1913	2/10	33,260	197,200	5.93	10,983	55,719	5.07
1914	14	47,093	309,692	6.58	9,921	57,542	5.80
1915	9	42,284	288,537	6.82	7,514	48,142	6.41
1916	13	52,506	369,104	7.03	3,042	27,859	9.16
1917	18	97,363	709,900	7.29	506	4,966	9.81
1918	25	107,261	1,047,243	9.76	-	-	-
1919	15	69,197	705,532	10.20	464	16,345	35.23
1920	18	73,204	921,732	12.59	2,762	36,201	13.11
1921	21	30,406	260,119	8.55	3,450	22,754	6.60
1922	23	60,680	397,729	6.55	4,805	33,034	6.87
1923	22	61,355	376,834	6.14	5,973	43,184	7.23
1924	23	55,469	395,470	7.13	5,541	47,208	8.52
1925	(1)	72,436	452,898	6.25	10,233	121,719	11.89
1926	(1)	61,936	364,413	5.88	16,669	174,241	10.45
1927-33	(3)	(3)	(3)	(3)	(3)	(3)	(3)
1934	36	40,544	214,185	5.28	44,132	547,353	12.40
1935	40	37,060	199,377	5.38	54,547	677,513	12.42
1936	40	46,126	266,883	5.79	75,066	955,807	12.73
1937	42	51,223	305,156	5.96	86,871	1,219,127	14.03
1938	39	45,933	286,127	6.23	69,509	1,092,942	15.72
1939	39	55,483	362,066	6.53	78,611	1,204,883	15.33
1940	50	70,097	516,865	7.37	21,689	454,632	20.96
1941	49	86,503	657,556	7.60	4/22,127	4/507,856	22.95
1942	41	71,500	516,887	7.23	49,236	1,219,473	24.77
1943	37	60,002	491,460	8.19	59,427	1,577,388	26.54
1944	35	57,987	524,521	9.05	64,428	1,916,794	29.75
1945	51	2/107,000	2/821,000	7.67	77,673	2,393,214	30.81
1946	59	140,707	1,006,231	7.15	84,078	2,704,803	32.17
1947	15	136,232	868,979	6.38	79,567	2,698,622	33.92
1948	41	129,581	929,560	7.17	91,073	3,194,656	35.08
1949	48	129,532	1,020,014	7.87	94,747	3,184,409	33.61
1950	48	130,723	1,142,566	8.74	124,382	3,866,927	31.09
1951	63	194,416	1,489,225	7.66	144,390	4,850,536	33.59
1952	62	210,582	1,729,511	8.21	167,404	6,502,452	38.84
1953	68	204,209	1,617,947	7.92	199,887	7,333,749	36.69
1954	85	244,163	2,257,591	9.25	240,940	8,836,325	36.67
1955	82	273,669	2,282,865	8.34	229,310	9,261,820	40.39

1/ Not available.
2/ Estimated.
3/ Peat industry not canvassed.
4/ 3/4 of a year.

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